

AMENDMENTS TO THE CLAIMS

Claim 1 (currently amended): A method of providing clocking signals over a bus, said method comprising:

providing a first clock signal which travels over a first conductive path of said bus in a first direction;

providing a second clock signal which travels over a second conductive path of said bus in a second direction opposite to said first direction; and

causing said first and second clock signals to have a predetermined phase relationship with respect to each other at a predetermined location on said bus;

wherein

said predetermined location is at approximately a mid point of a plurality of spaced locations each adapted to accept a device, and supply said device with said first and second clock signals,

said predetermined phase relationship is substantially an in-phase relationship,

said first and second clock signals are independent signals,

one of said first and second clock signals is a data write clock signal, and

the other of said first and second clock signals is a data read clock signal.

Claim 2 (canceled):

Claim 3 ((currently amended): The [[A]] method of ~~as in~~ claim 1, ~~or~~ 2 wherein said act of causing comprises:

detecting the phase relationship of said first and second clock signals at said predetermined location; and

adjusting at least one of said first and second clock signals to obtain said predetermined phase relationship.

Claim 4 (currently amended): The [[A]] method of ~~as in~~ claim 3, ~~1 or~~ 2 wherein said act of causing comprises:

configuring the signal propagation characteristics of at least one of said first and second conductive paths to obtain said predetermined relationship.

Claim 5 (currently amended): The [[A]] method of ~~as in~~ claim 4, wherein said act of configuring comprises:

configuring the path length of said first and second conductive paths to obtain said predetermined phase relationship.

Claims 6-8 (canceled):

Claim 9 (currently amended): The ~~[[A]]~~ of as in claim 1, ~~[[7]]~~ wherein each of said input/output devices comprise a memory subsystem.

Claim 10 (currently amended): The ~~[[A]]~~ of as in claim 9, wherein said data write and data read signals have the same clock period and wherein said memory subsystems are spaced along said bus and said predetermined phase relationship and distance of said memory modules from said predetermined location is such that the phase deviation of said data write and data read clock signals at any one of said memory subsystems is less than one half of a data bit time.

Claim 11 (currently amended): The ~~[[A]]~~ method of as in claim 10, wherein said memory subsystems are equally spaced along said bus.

Claim 12 (currently amended): The ~~[[A]]~~ method of as in claim 9, wherein each of said memory subsystems comprises a plurality of memory storage devices, and said method further comprises receiving a data write clock signal at said memory subsystem, regenerating a plurality of data clock write signals from a received data write clock signal, and respectively providing said plurality of regenerated data write signals to said plurality memory storage devices.

Claim 13 (currently amended): The [[A]] method of ~~as in~~ claim 12, wherein each of said plurality of regenerated data write clock signals are substantially in phase with each other.

Claim 14 (currently amended): The [[A]] method of ~~as in~~ claim 13, wherein each of said plurality of regenerated data write clock signals at said memory storage devices of an associated memory subsystem are substantially in phase with a write clock signal received at said associated memory subsystem.

Claim 15 (currently amended): The [[A]] method of ~~as in~~ claim 9, wherein each of said memory subsystems comprises a plurality of memory storage devices and said method further comprises receiving a data read clock signal, regenerating a plurality of data read signals from said received data read clock signal and respectively providing said plurality of regenerated data read clock signals to said plurality of memory storage devices.

Claim 16 (currently amended): The [[A]] method of ~~as in~~ claim 15, wherein said plurality of regenerated data read signals are regenerated inside a device which produces the data write clock signal and data read clock signal.

Claim 17 (currently amended): The [[A]] method of ~~as in~~ claim 15, wherein said regeneration of said data read clock signals occurs at a motherboard which contains said bus.

Claim 18 (currently amended): The [[A]] method of ~~as in~~ claim 15, wherein one of said plurality of regenerated data read clock signals is used in said act of detecting said phase relationship.

Claim 19 (currently amended): The [[A]] method of ~~as in~~ claim 15, wherein said each of said plurality of regenerated data read clock signals are in phase with each other.

Claim 20 (currently amended): The [[A]] method of ~~as in~~ claim 19, wherein each of said plurality of regenerated data read clock signals are in phase with said received data read clock signal.

Claim 21 (currently amended): The [[A]] method of ~~as in~~ claim 3, wherein said bus interconnects a memory controller with at least one memory subsystem, said memory controller, issuing said data write clock signal and said data read clock signal on said first and second conductive paths, detecting said phase relationship of said data write clock signal and data read clock signal at said predetermined location, and adjusting the timing of at least one of said data write signal and said data read clock signal to obtain said predetermined phase relationship at said predetermined location.

Claim 22 (currently amended): The [[A]] of ~~as in~~ claim 21, wherein the conductive path over which said data write clock signal passes is terminated at an [[d]] end thereof spaced from said memory controller, said memory subsystem being located between said controller and the terminated end of said data write clock signal conductive path.

Claim 23 (currently amended): The [[A]] method of ~~as in~~ claim 21, wherein the path over which said data read clock signal passes is a loop back conductive signal path.

Claim 24 (currently amended): The [[A]] method of ~~as in~~ claim 23, wherein said loop back conductive signal path is terminated at an end thereof.

Claim 25 (currently amended): The [[A]] method of ~~as in~~ claim 23, wherein said loop back conductive signal path terminates at both ends at said memory controller.

Claim 26 (currently amended): The [[A]] method of ~~as in~~ claim 21, wherein said memory controller generates said data read clock signal off said data write clock signal.

Claim 27 (currently amended): The [[A]] method of ~~as in~~ claim 26, wherein said memory controller adjusts a phase relationship between said data write clock signal

and data read clock signal using a phase lock loop or delay lock loop which sets a phase relationship between said data write clock signal and data read clock signal at said predetermined location.

Claim 28 (currently amended): The [[A]] method of ~~as in~~ claim 27, further comprising receiving at said phase lock loop feedback signals representing the relative phase relationship of said data write clock signal and data read clock signal at said predetermined location and using said relative phase relationship to adjust the phase relationship of said data write clock signal and data read clock signal at said predetermined location.

Claim 29 (currently amended): The [[A]] method of ~~as in~~ claim 9, wherein said memory subsystem comprises a plurality of memory storage devices and is connected over said bus to a memory controller, said memory controller issuing a data write clock signal which is received at said memory subsystem, said method further comprising regenerating a plurality of data write clock signals from a received data write clock signal and respectively providing said regenerated data write clock signals to said memory storage devices.

Claim 30 (currently amended): The [[A]] method of ~~as in~~ claim 29, further comprising issuing a plurality of data read clock signals from said memory controller which are received at said memory subsystem and respectively providing said received data read clock signals to said memory storage devices.

Claim 31 (currently amended): The [[A]] method of ~~as in~~ claim 29, further comprising issuing a data read clock signal from said memory controller and regenerating from said issued data read clock signal a plurality of regenerated data read clock signals and respectively applying said plurality of regenerated data read clock signals to said memory storage devices.

Claim 32 (currently amended): The [[A]] method of ~~as in~~ claim 31, wherein regeneration of said data read clock signals is performed at a motherboard which contains said bus.

Claim 33 (currently amended): The [[A]] method of ~~as in~~ claim 9, wherein said memory subsystems are spaced along said bus such that when a data read clock signal and a data write clock signal are received thereat a predetermined minimum time exists between them.

Claim 34 (currently amended): The [[A]] method of ~~as in~~ claim 33, wherein said predetermined minimum time is such that a data read clock signal does not arrive at a said memory subsystem during a period of time following initialization of a data write signal, said period of time being about 50% of the period of the data write clock signal.

Claim 35 (currently amended): The [[A]] method of ~~as in~~ claim 32, wherein at least one of said regenerated data read signals is used in said phase relationship determination.

Claim 36 (currently amended): The [[A]] method of ~~as in~~ claim 29, wherein said memory subsystem includes a register for receiving command and address data from command and address paths of said bus, said method further comprising providing command and address data to said memory storage devices, regenerating an additional data write clock signal from said received data write clock signal, and using said additional regenerated data write clock signal to control the capture of command and address data within said register.

Claim 37 (currently amended): The [[A]] method of ~~as in~~ claim 36, wherein the frequency of said additional data write clock signal is at a frequency of X/N where X is the frequency of said received data write clock signal and N is an integer.

Claim 38 (currently amended): The [[A]] method of ~~as in~~ claim 9, wherein said memory subsystem is a memory module which is capable of being socket connected to said bus.

Claim 39 (currently amended): The [[A]] method of ~~as in~~ claim 9, wherein each memory subsystem comprises a plurality of memory storage devices, said method further comprising issuing a data ready signal from at least one of said memory storage

devices onto said bus when said plurality of memory storage devices are about to place data on said bus.

Claim 40 (currently amended): The [[A]] method of ~~as in~~ claim 9, wherein each memory subsystem is coupled to a memory controller over said bus and each memory subsystem comprises a plurality of memory storage devices, said method further comprising calibrating the turn on time of data receivers in said memory controller using a known data pattern contained in at least one of said memory storage devices.

Claim 41 (currently amended): The [[A]] method of ~~as in~~ claim 40, wherein said act of calibrating comprises writing said known data pattern to said at least one memory storage device, issuing a read command to said at least one memory storage device from said memory controller, detecting an aligning edge of said known data pattern at said memory controller and determining the time between the issuance of said read command and the aligning edge of said known data pattern and using said determined time difference to turn on data receivers in said memory controller following issuance of a read command.

Claim 42 (currently amended): A clock system for a data bus, comprising:

a data bus comprising[[:]] a plurality of data paths,[[:]] a first clock signal path for propagating a first clock signal in a first direction along said bus,[[:]] and a second clock signal path for propagating a second clock signal in a second direction opposite to said first direction along said bus;

a bus controller for issuing said first and second clock signals in said first and second clock signal paths; and

circuitry for causing said first and second clock signals to have a predetermined phase relationship with respect to each other at a predetermined location along said bus;

wherein

said predetermined location is at approximately a mid point of a plurality of spaced locations each adapted to

accept a device, and

supply said device with said first and second clock signals, such that when said first and second clock signals are received at one of said plurality of spaced locations, a predetermined minimum time equal to at least about half a clock period of one of said first or second clock signals exists before said first and second clock signals are received at another one of said plurality of spaced locations,

said first and second clock signals are independent signals,

one of said first and second clock signals is a data write clock signal, and

the other of said first and second clock signals is a data read clock signal.

Claim 43 (currently amended): The ~~as in~~ [[A]] system of ~~as in~~ claim 42, wherein said predetermined phase relationship is substantially an in-phase relationship.

Claim 44 (currently amended): The [[A]] system of ~~as in~~ claim 42, wherein said predetermined phase relationship is a function of a signal propagating characteristic~~[[s]]~~ of said first and second clock signal paths.

Claim 45 (currently amended): The [[A]] system of ~~as in~~ claim 42, wherein said signal predetermined phase relationship is a function of a path length~~[[s]]~~ of said first and second clock signal paths.

Claim 46 (currently amended): The [[A]] system of ~~as in~~ claim 42, wherein said circuitry is a phase detecting circuit associated with said bus controller, said phase detecting circuit detecting the phase relationship of said first and second clock signals at said predetermined location and adjusting at least one of said first and second clock signals to obtain said predetermined phase relationship.

Claims 47-50 (canceled):

Claim 51 (currently amended): The [[A]] system of ~~as in~~ claim 42, [[49]] wherein said ~~each of said input/output~~ devices each comprise a memory subsystem.

Claim 52 (currently amended): The [[A]] system of ~~as in~~ claim 51, wherein

said data write and data read clock signals have the same clock period, and

~~wherein said memory subsystems are spaced along said bus and said predetermined phase relationship and distance of said memory modules from said predetermined location is such that the~~ a phase deviation of said data write and data read clock signals at any one of said memory subsystems is less than one half of a data bit time.

Claim 53 (currently amended): The [[A]] system of ~~as in~~ claim 52, wherein said memory subsystems are equally spaced along said bus.

Claim 54 (currently amended): The [[A]] system of ~~as in~~ claim 51, wherein each of said memory subsystems comprises a plurality of memory storage devices, said system further comprising a data write regeneration circuit which regenerates a plurality of data write clock signals from a received data write clock signal and respectively supplies said regenerated data write clock signals to said memory storage devices.

Claim 55 (currently amended): The [[A]] system of ~~as in~~ claim 54, wherein said plurality of regenerated data write clock signals are in phase with each other.

Claim 56 (currently amended): The [[A]] system of ~~as in~~ claim 55, wherein said plurality of regenerated data write clock signals at said memory storage devices are in phase with said data write clock signal received at an associated memory subsystem.

Claim 57 (currently amended): The [[A]] system of ~~as in~~ claim 54, wherein said data write clock generating circuit comprises a plurality of buffer circuits for respectively providing said plurality of regenerated data circuit clock signals.

Claim 58 (currently amended): The [[A]] system of ~~as in~~ claim 54, wherein said data write clock regenerating circuit comprises a phase lock loop circuit.

Claim 59 (currently amended): The [[A]] system of ~~as in~~ claim 51, wherein each of said memory subsystems comprises a plurality of memory storage devices, said system further comprising a circuit for regenerating a plurality of data read clock signals and respectively providing said plurality of regenerated data read clock signals to said plurality of memory storage devices.

Claim 60 (currently amended): The [[A]] system of ~~as in~~ claim 59, wherein said circuit for regenerating said data read clock signals is located at a motherboard which contains said bus.

Claim 61 (currently amended): The [[A]] system of ~~as in~~ claim 60, wherein said regenerated read data clock signal is generated inside a transmitting device which generates said data write clock signal and data read clock signal.

Claim 62 (currently amended): The [[A]] system of ~~as in~~ claim 60, further comprising a phase detector associated with said bus controller for detecting the phase relationship of said data write clock signal at said predetermined location and adjusting at least one of said write clock signals and read clock signals to obtain said predetermined relationship.

Claim 63 (currently amended): The [[A]] system of ~~as in~~ claim 62, wherein at least one of said plurality of regenerated data read signals is used by said phase detector to detect said phase relationship.

Claim 64 (currently amended): The [[A]] system of ~~as in~~ claim 59, wherein said each of said plurality of regenerated data read clock signals are in phase with each other.

Claim 65 (currently amended): The [[A]] system of ~~as in~~ claim 64, wherein each of said plurality of regenerated data read clock signals are in phase with said received data read clock signal.

Claim 66 (currently amended): The [[A]] system of ~~as in~~ claim 59, wherein said circuit for regenerating said plurality of data read clock signals comprises a plurality of buffer circuits.

Claim 67 (currently amended): The [[A]] system of ~~as in~~ claim 59, wherein said circuit for regenerating said plurality of data read clock signals comprises a PLL circuit.

Claim 68 (currently amended): A memory system comprising:

a data bus comprising a plurality of read/write data paths, a data write clock signal path for propagating a data write clock signal in a first direction along said bus, and a data read clock signal path for propagating a data read clock signal in a second direction along said bus, said second direction being opposite said first direction;

a memory controller coupled to said bus for respectively issuing said data write and data read clock signals on said data write and data read clock signal paths and for setting a predetermined phase relationship between said data write and data read clock signals at a predetermined location along said bus, [[;]] said predetermined location being at approximately a mid point of a plurality of spaced locations each adapted to accept a device, and supply said device with said data write clock and data read clock signals;

and

at least one memory subsystem coupled to said bus for exchanging data with said memory controller in accordance with timing set by said data write and data read clock signals;

wherein

said data write clock signal, and

said data read clock signal are independent signals.

Claim 69 (currently amended): The [[A]] memory system of ~~as in~~ claim 68, wherein each said memory subsystem comprises a plurality of memory devices which transmit data to and receive data from said data bus in accordance with said timing set by said data write and data read clock signals.

Claim 70 (currently amended): The [[A]] memory system of ~~as in~~ claim 69, further comprising a plurality of memory subsystems coupled to said bus at spaced locations therealong, said predetermined location being located between a first location where a memory subsystem which is nearest to said memory controller is coupled to said bus and a second location where a memory subsystem which is farthest from said memory controller is coupled to said bus.

Claim 71 (currently amended): The [[A]] memory system of ~~as in~~ claim 70, wherein said predetermined location is located substantially midway of said first and second locations.

Claim 72 (currently amended): The [[A]] memory system of ~~as in~~ claim 68, wherein said memory controller has an associated phase lock loop circuit for maintaining said predetermined phase relationship, said phase lock loop or delay lock loop circuit receiving data write and data read clock signals from said predetermined location as inputs and providing an output which adjusts the phase relationship of issued data write and data read clock signals.

Claim 73 (currently amended): The [[A]] memory system of ~~as in~~ claim 68, further comprising a plurality of memory subsystems spaced along said bus and wherein said data write clock signal and data read clock signal have the same period, and wherein said predetermined phase relationship and distance of said memory subsystems from said predetermined location is such that the phase deviation of said data write and data read clock signal at any one of said memory subsystems is less than one half of a data bit time.

Claim 74 (currently amended): The [[A]] memory system of ~~as in~~ claim 68, wherein said memory subsystem comprises a plurality of memory storage devices and a data write clock regeneration circuit for regenerating a plurality of data write clock signals

from a data write clock received from said bus and respectively providing said regenerated data write clock signals to said memory storage devices.

Claim 75 (currently amended): The [[A]] memory system of ~~as in~~ claim 68, wherein said memory subsystem comprises a plurality of memory storage devices, said memory system further comprising a data read clock regeneration circuit for regenerating a plurality of data read clock signals from a data read clock signal received from said bus and respectively providing said plurality of regenerated data read clock signals to said plurality of memory storage devices.

Claim 76 (currently amended): The [[A]] memory system of ~~as in~~ claim 75, further comprising a motherboard which contains said bus, said data read clock regenerating circuit being provided at said motherboard.

Claim 77 (currently amended): The [[A]] memory system of ~~as in~~ claim 76, wherein said regenerated read data clock signals are generated inside a transmitting device which generates said data write clock signal and data read clock signal.

Claim 78 (currently amended): The [[A]] memory system of ~~as in~~ claim 68, wherein said data write signal path is terminated at an end thereof spaced from said memory controller, said memory subsystem being located between said controller and said terminated end, and said data read clock signal path is a loop back signal path.

Claim 79 (currently amended): The [[A]] memory system of ~~as in~~ claim 78, wherein said loop back signal path is terminated at an end thereof.

Claim 80 (currently amended): The [[A]] memory system of ~~as in~~ claim 78, wherein said loop back signal path terminates at both ends at said memory controller.

Claim 81 (currently amended): The [[A]] memory system of ~~as in~~ claim 68, further comprising a plurality of memory subsystems spaced along said bus such that when a data write clock signal and a data read signal are received at each memory subsystem a predetermined minimum time exists between them.

Claim 82 (currently amended): The [[A]] memory system of ~~as in~~ claim 81, wherein said predetermined minimum time is about 50% of a data bit time.

Claim 83 (previously presented): A memory system comprising:

a data bus comprising

a plurality of read/write data paths, a data write clock signal path for propagating a data write clock signal in a first direction along said bus, and

a data read clock signal path for propagating a data read clock signal in a second direction along said bus, said second direction being opposite said first direction;

a memory controller coupled to said bus for respectively issuing said data write and data read clock signals on said data write and data read clock signal paths and for setting a predetermined phase relationship between said data write and data read clock signals at a predetermined location along said bus; and

a plurality of memory subsystems coupled to and spaced along said bus for exchanging data with said memory controller in accordance with timing set by said data write and data read clock signals;

said memory controller setting a phase relationship between said data write and data read clock signals at said predetermined location which ensures that at any one of said memory subsystems a data read operation is not initiated following initiation of a data write operation during a time period which is equal to about 50% of the period of a data bit time;

wherein said data write clock signal and said data read clock signal are independent signals.

Claims 84 - 88 (canceled):